

FIG. 1

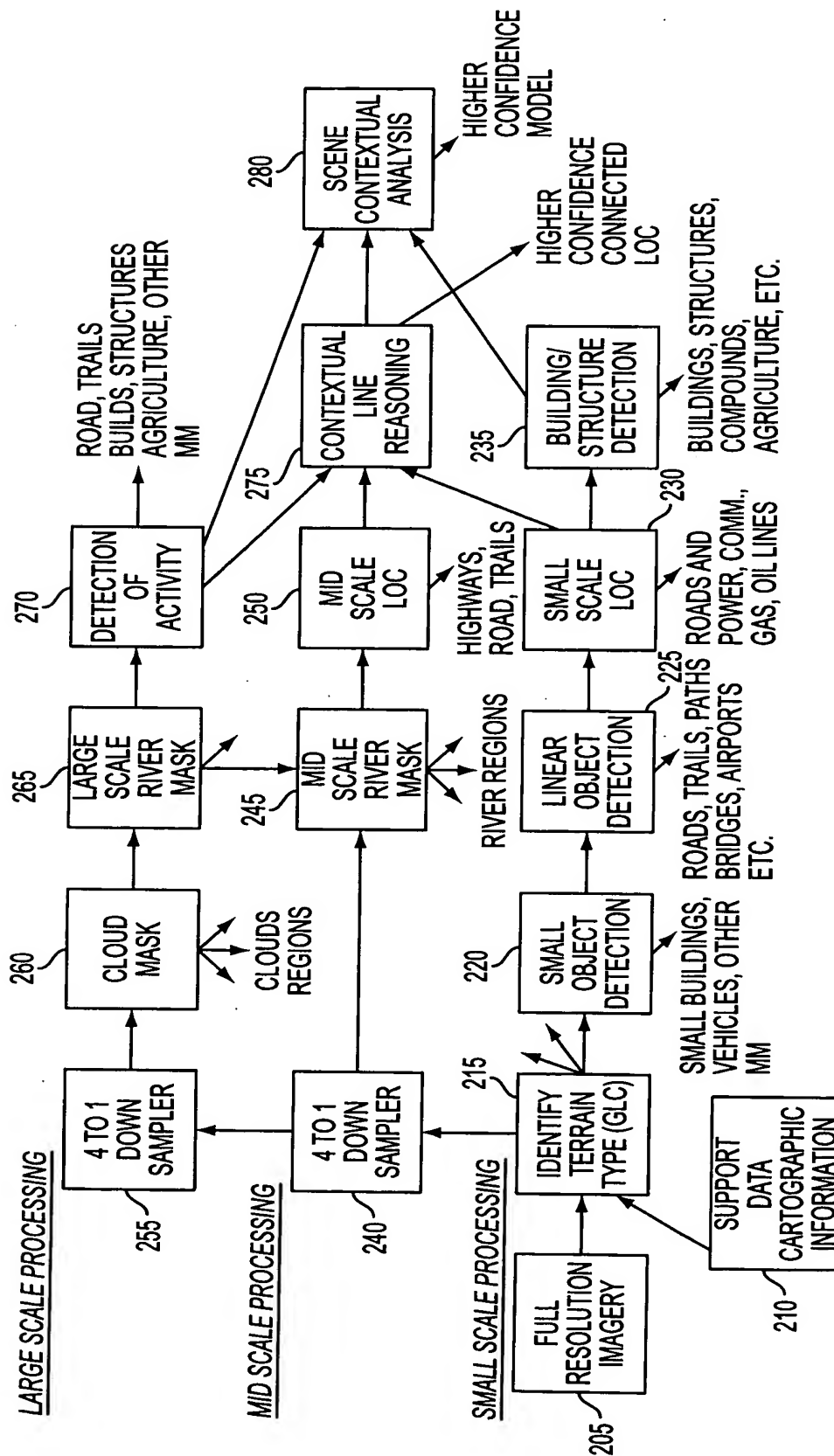


FIG. 2

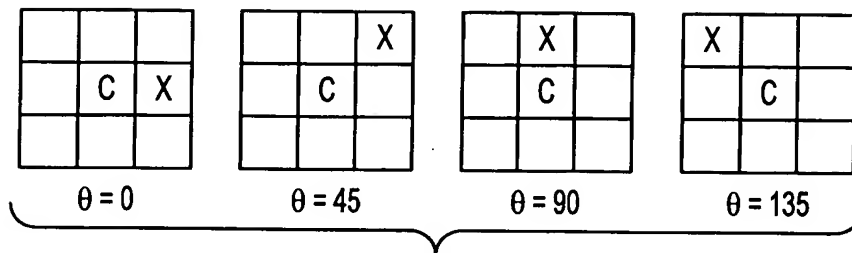


FIG. 3

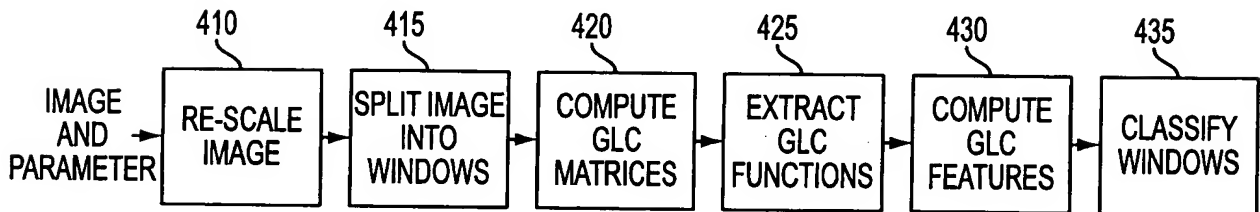


FIG. 4

$$\begin{aligned}
 &\text{ENERGY} \\
 &E_n = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} (G(i,j))^2 \\
 &\text{ENTROPY} \\
 &E_t = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} (G(i,j) \log(G(i,j))) \\
 &\text{CONTRAST} \\
 &C_t = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} (G(i,j) \times (i-j)^2) \\
 &\text{INVERSE_DIFFERENCE_MOMENT} \\
 &E_n = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} \frac{G(i,j)}{1 + (i-j)^2} \\
 &\text{CORRELATION} \\
 &C_r = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} \frac{i \times j \times G(i,j) - \mu_x \times \mu_y}{\sigma_x \times \sigma_y}
 \end{aligned}$$

FIG. 5

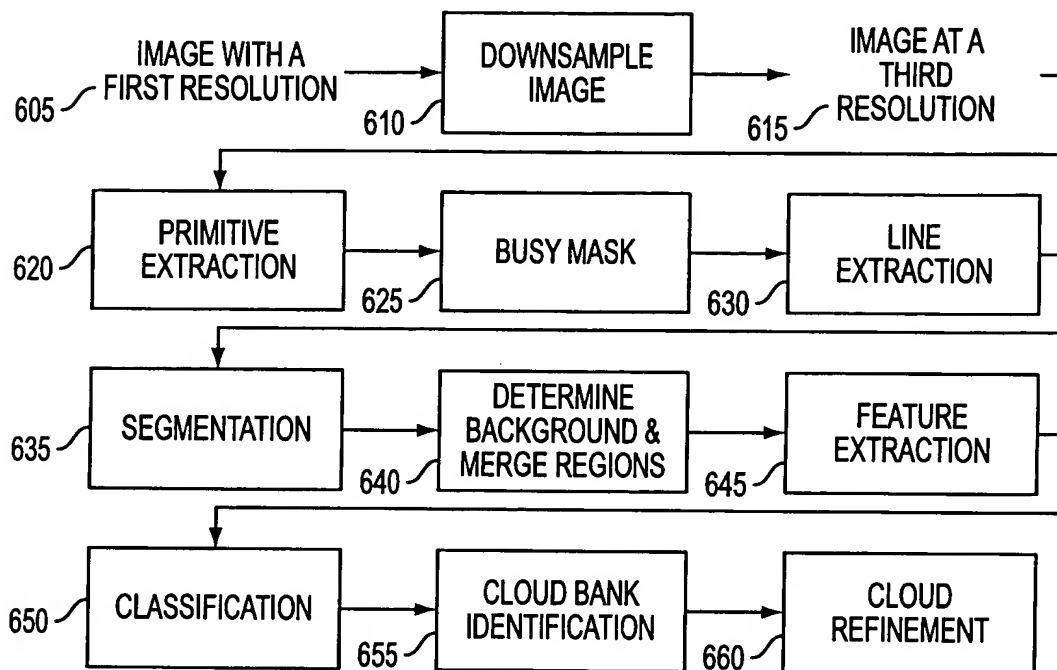


FIG. 6

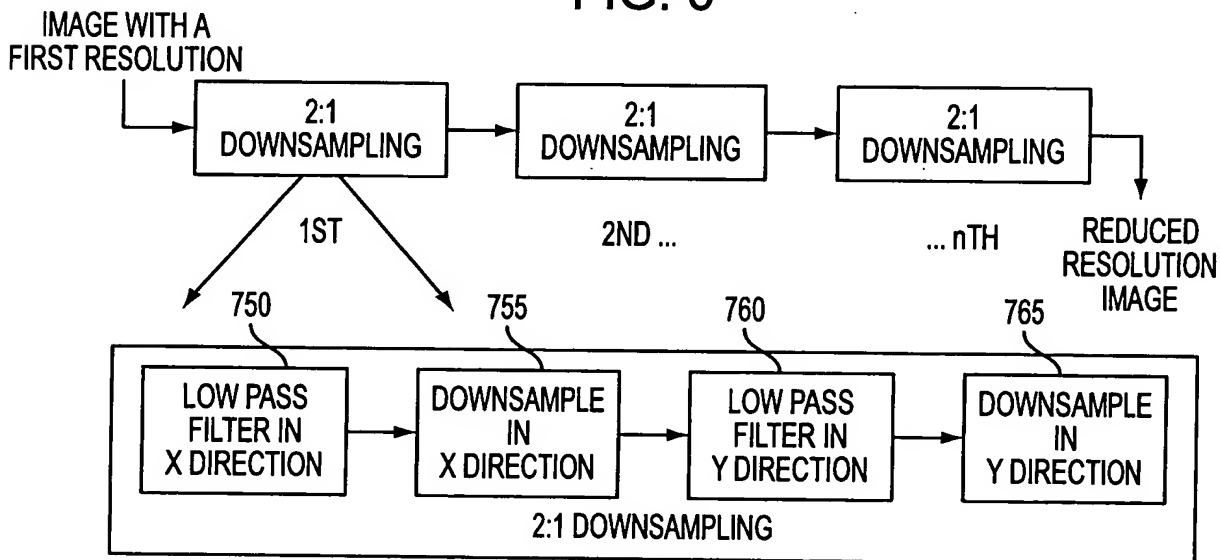


FIG. 7A

1	4	6	4	1
1	16	24	16	1
1	24	36	24	1
1	16	24	16	1
1	4	6	4	1

FULL 6 BY 6 CONVOLUTION FILTER

FIG. 7B

1	4	6	4	1
---	---	---	---	---

X DIRECTION FILTER

1
4
6
4
1

Y DIRECTION FILTER

FIG. 7C

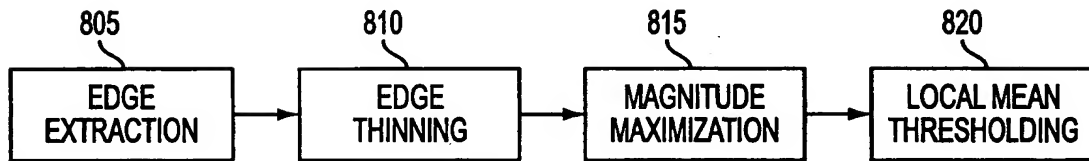


FIG. 8

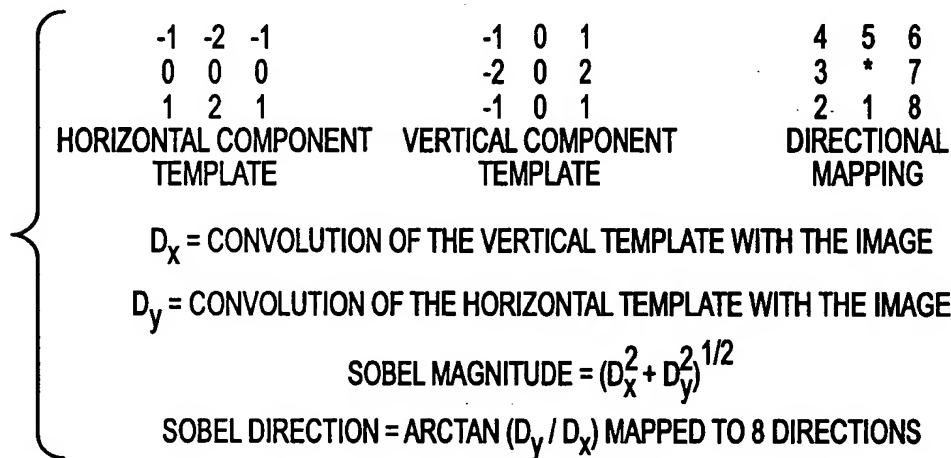


FIG. 9A

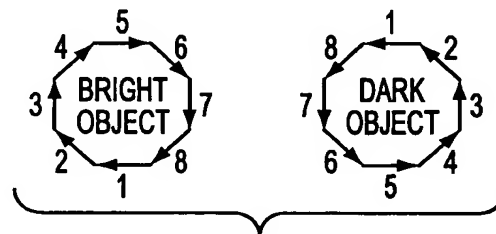


FIG. 9B

<u>DIRECTIONS 3 & 7</u>	<u>DIRECTIONS 1 & 5</u>	<u>DIRECTIONS 2 & 6</u>	<u>DIRECTIONS 4 & 8</u>
O O O O O	O X X X O	O O O X O	O X O O O
X O O O X	O O X O O	O O O X X	X X O O O
X X C X X	O O C O O	O O C O O	O O C O O
X O O O X	O O X O O	X X O O O	O O O X X
O O O O O	O X X X O	O X O O O	O O O X O

C = CENTER PIXEL X = NON-ZERO PIXEL O = DON'T CARE PIXEL

FIG. 10

```

      XXX
     XXXXX
    XXXXXX
   XXXXXX
  XXXXXX
 XXXXX
XXXXX

```

FIG. 11A

```

      XXX
     XXX
    XXXX
   XXXX
  XXXX
 XXXX
XXXX
XX

```

FIG. 11B

X 1 X	X 1 X	XXO	OXX
XC 1	1CX	1CX	XC 1
OXX	XXO	X 1 X	X 1 X

1 = NON-ZERO PIXEL, O = ZERO PIXEL, X = DON'T CARE

FIG. 12

```

      XXX
     XXX
    XXX
   XXX
  XXX
 XXX
XXXX
XX

```

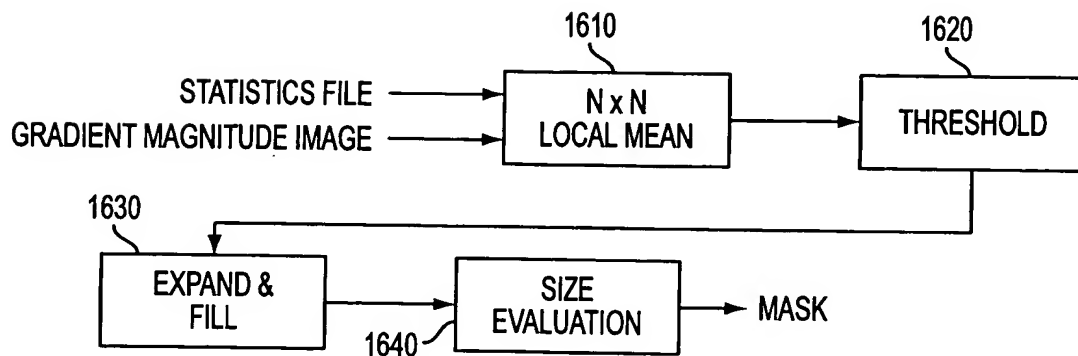
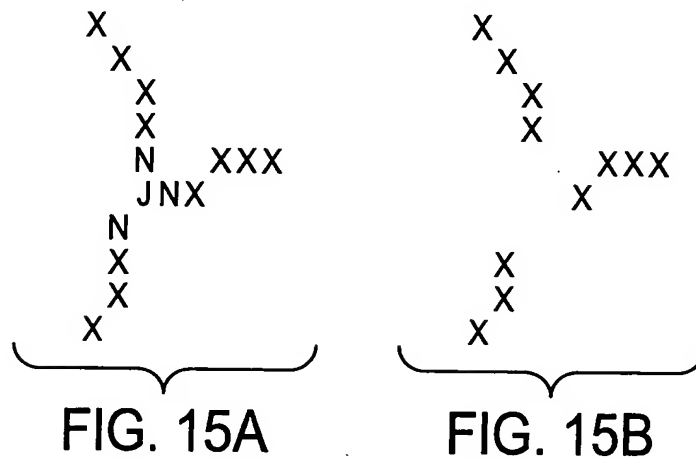
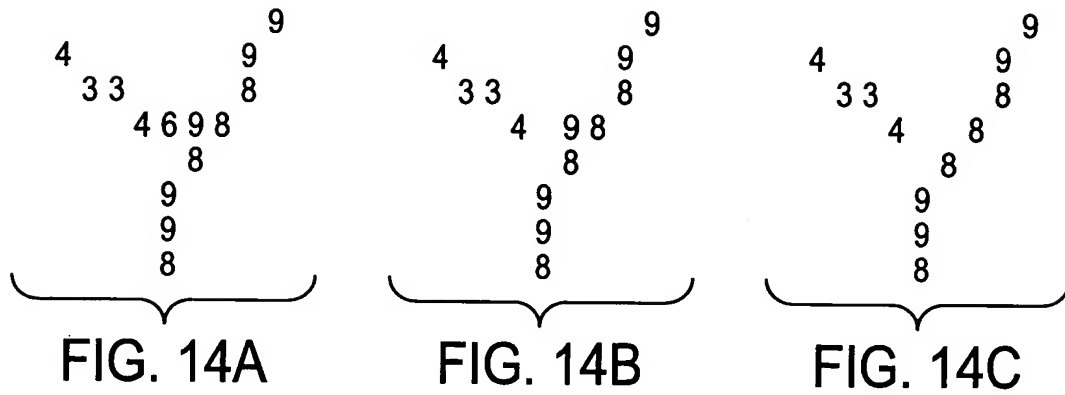
FIG. 13A

```

      XX
     XX
    XX
   XX
  XX
 XX
XX
XX

```

FIG. 13B



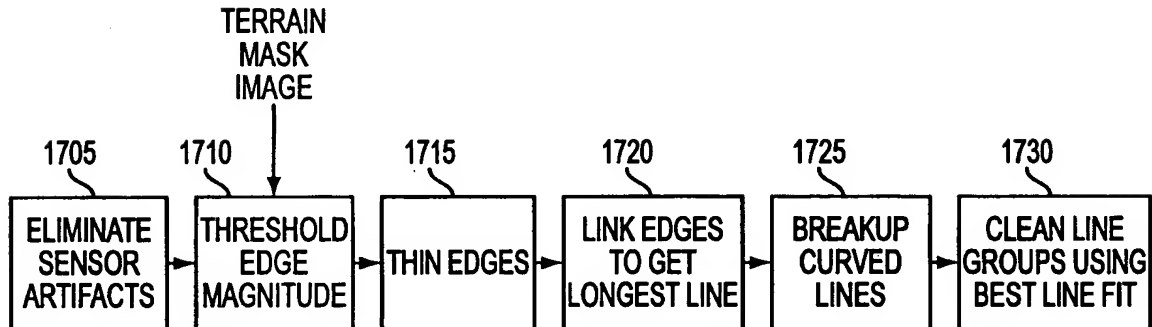
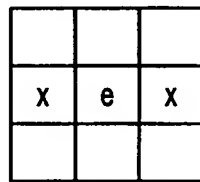
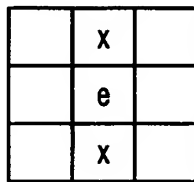


FIG. 17



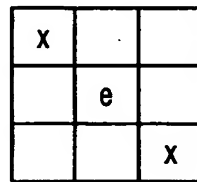
3 AND 7

FIG. 18A



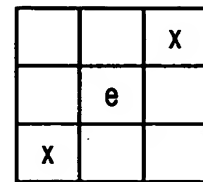
1 AND 5

FIG. 18B



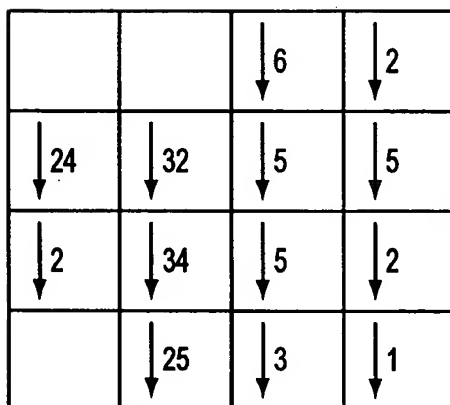
4 AND 8

FIG. 18C



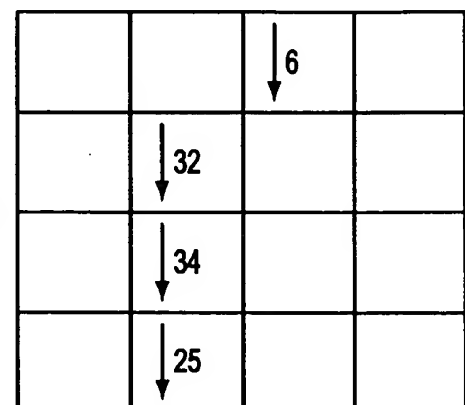
2 AND 6

FIG. 18D



EDGES DIRECTIONS AND MAGNITUDES

FIG. 19A



THINNING EDGES

FIG. 19B

[illegible]

NO NOISE PRESENT

FIG. 20A

[illegible]

NOISE PRESENT

FIG. 20B

	1		2		3		4		5		6		7	
REGIONS														
EDGE DIRECTION														
A) NON-OVERLAPPING REGION	1	2	1	1	1	1	2	2	1	1	1	8	1	
	1	1	1	1	1	1	1	1	1	1	1	8	1	
B) NON-OVERLAPPING REGION	8	2	8	8	8	8	2	2	8	8	8	8	8	

DIRECTION 1 = DIRECTION 1 AND DIRECTION 2

DIRECTION 2 = DIRECTION 2 AND DIRECTION 3

DIRECTION 3 = DIRECTION 3 AND DIRECTION 4

DIRECTION 4 = DIRECTION 4 AND DIRECTION 5

DIRECTION 5 = DIRECTION 5 AND DIRECTION 6

DIRECTION 6 = DIRECTION 6 AND DIRECTION 7

DIRECTION 7 = DIRECTION 7 AND DIRECTION 8

DIRECTION 8 = DIRECTION 8 AND DIRECTION 1

FIG. 20C



FIG. 21A

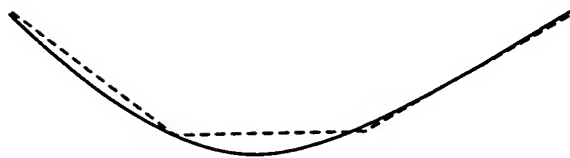


FIG. 21B

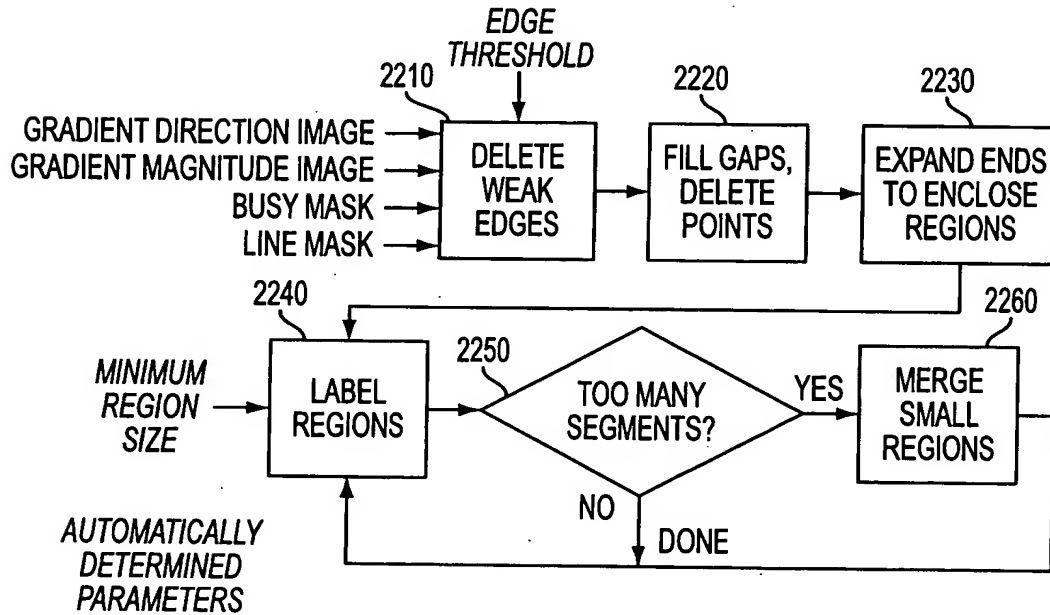


FIG. 22

E E O	O E E	O E O	O E O
O C O	O C O	O C O	O C O
O E O	O E O	E E O	O E E

TEMPLATES FOR VERTICAL POINT GAP

C = CENTER PIXEL, VALUE 1 E = PIXEL VALUE 1 O = ZERO PIXEL VALUE

E O O	O O E	O O O	O O O
E C E	E C E	E C E	E C E
O O O	O O O	E O O	O O E

TEMPLATES FOR HORIZONTAL POINT GAP

FIG. 23

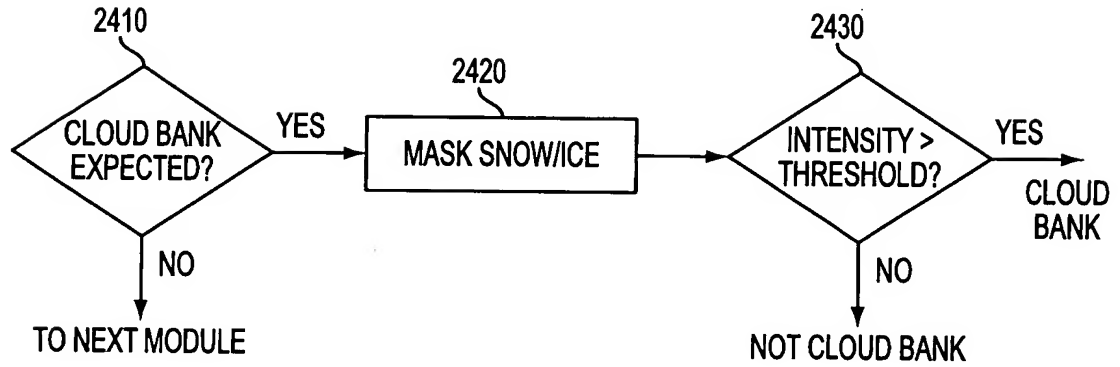


FIG. 24

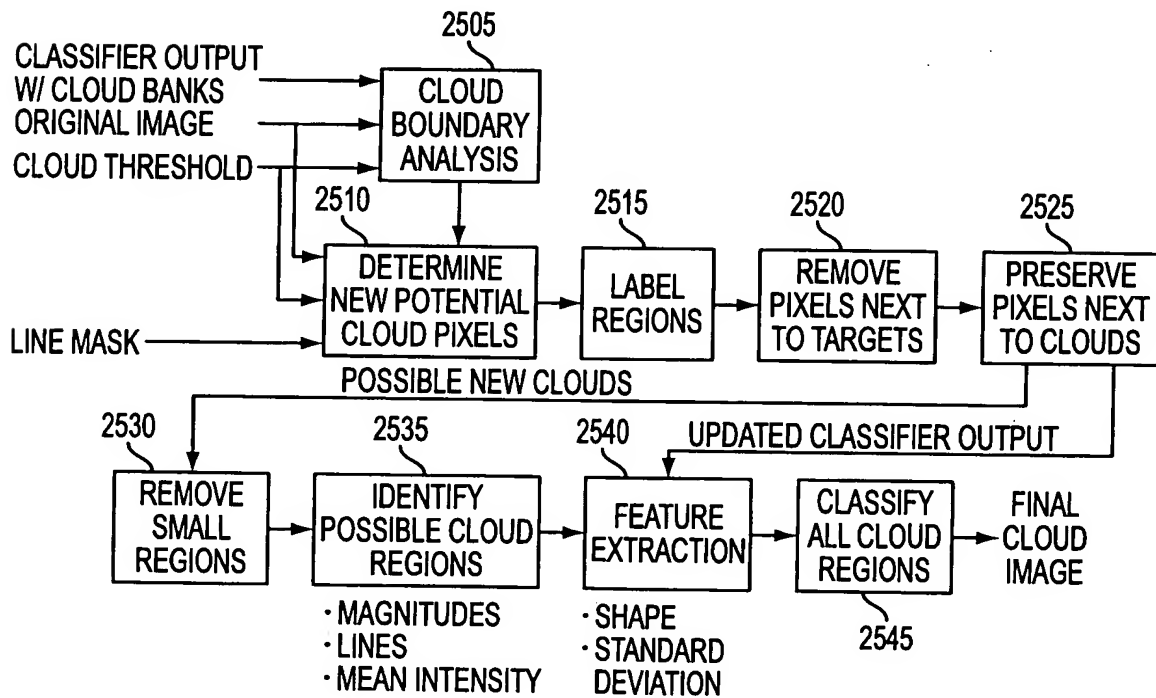


FIG. 25

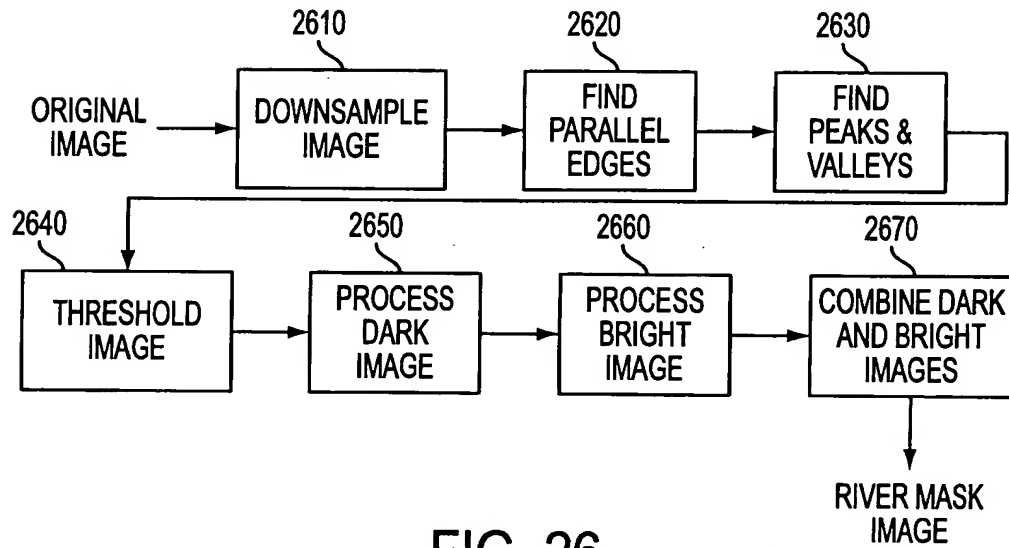


FIG. 26

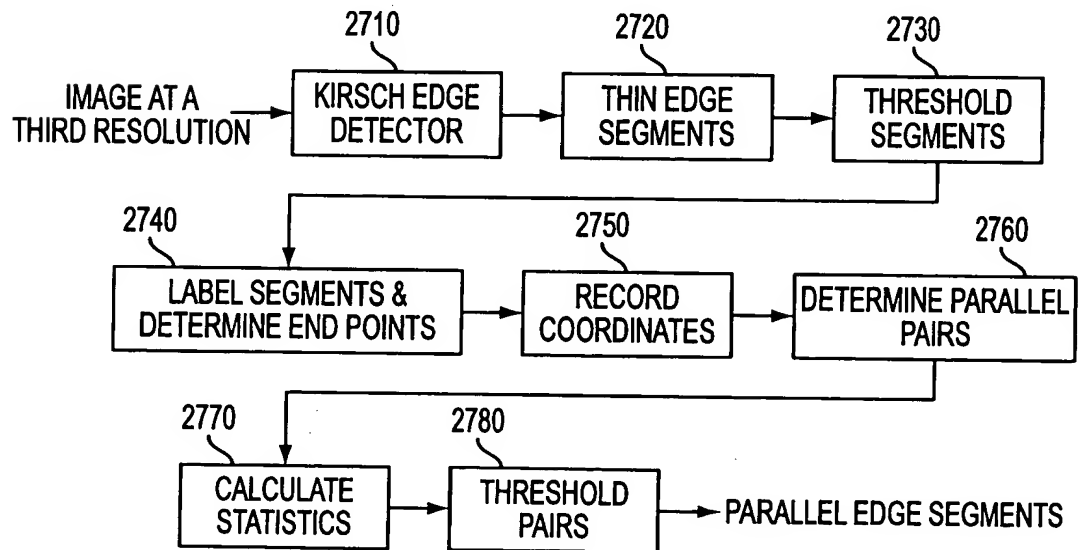


FIG. 27

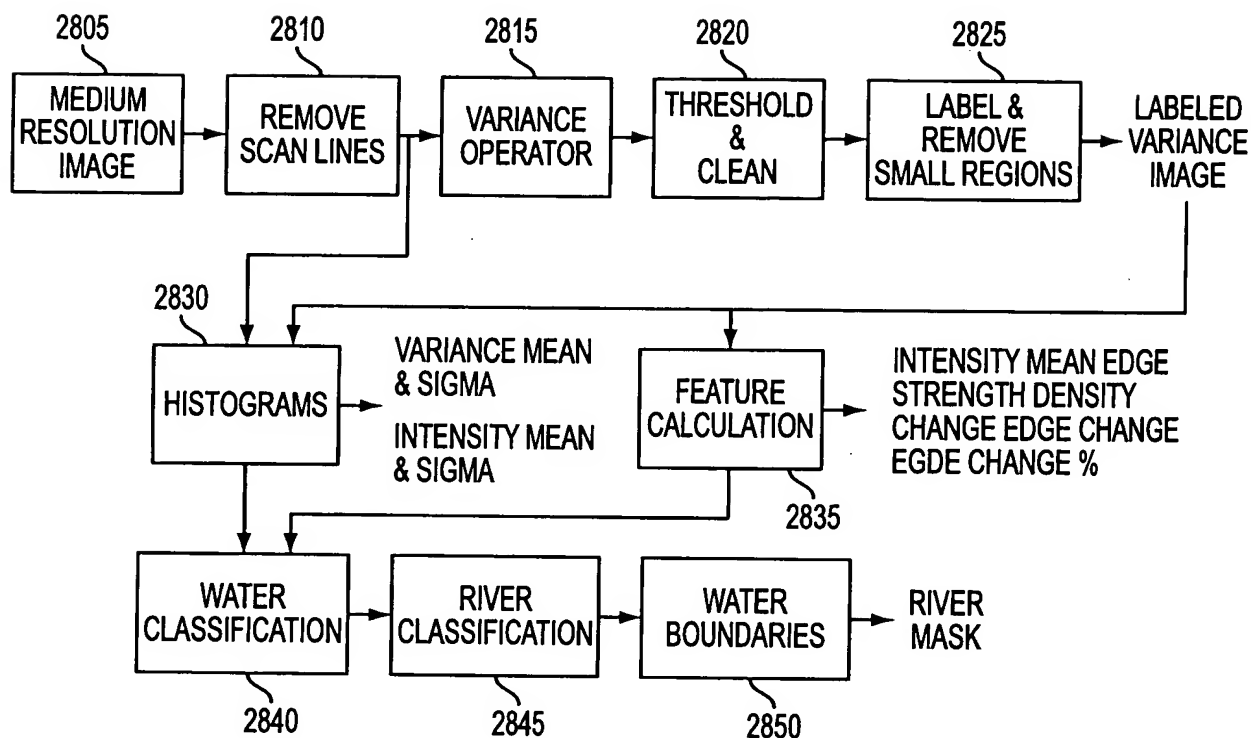


FIG. 28

$a_{-1,-1}$	$a_{0,-1}$	$a_{1,-1}$
$a_{-1,0}$	$a_{0,0}$	$a_{1,0}$
$a_{-1,1}$	$a_{0,1}$	$a_{1,1}$

3 BY 3 NEIGHBORHOOD

FIG. 29A

$$\sigma = \frac{1}{n} \sum_{j=-k}^k \sum_{i=-k}^k (a_{ij} - \mu)^2$$

WHERE

$$\mu = \frac{1}{n} \sum_{i=-k}^k (a_{ij})$$

3 BY 3 NEIGHBORHOOD $k=1$

FIG. 29B

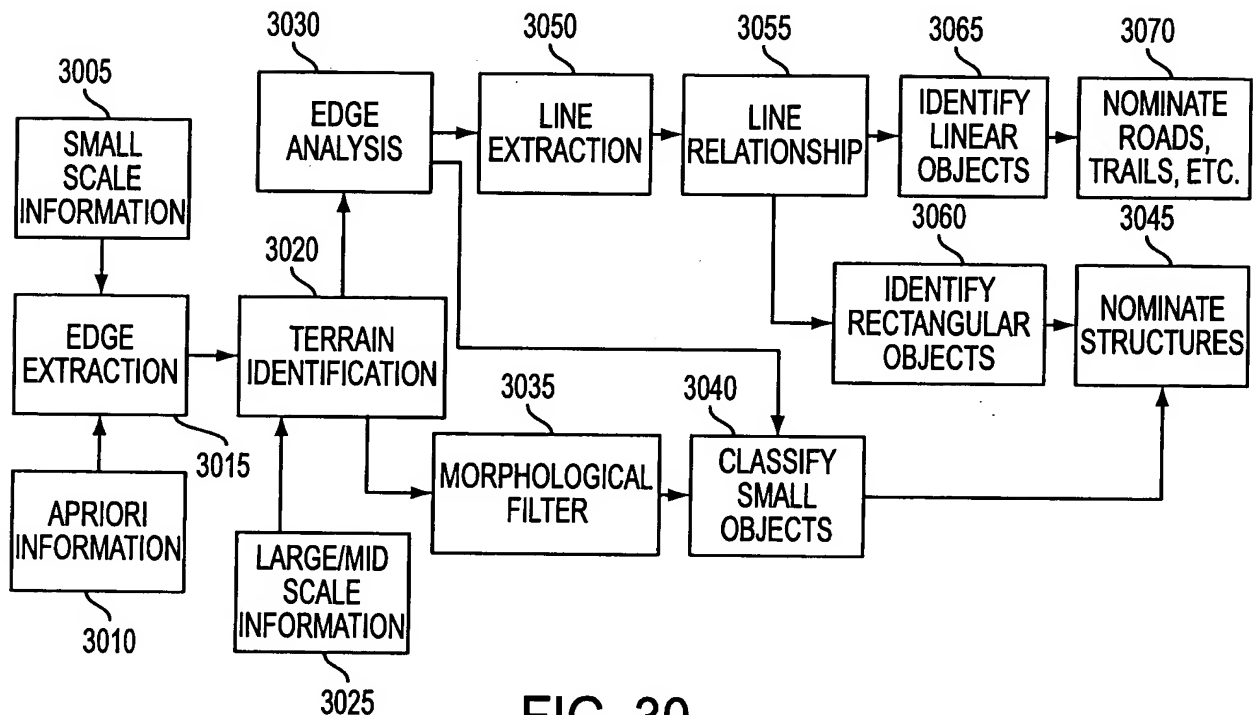


FIG. 30

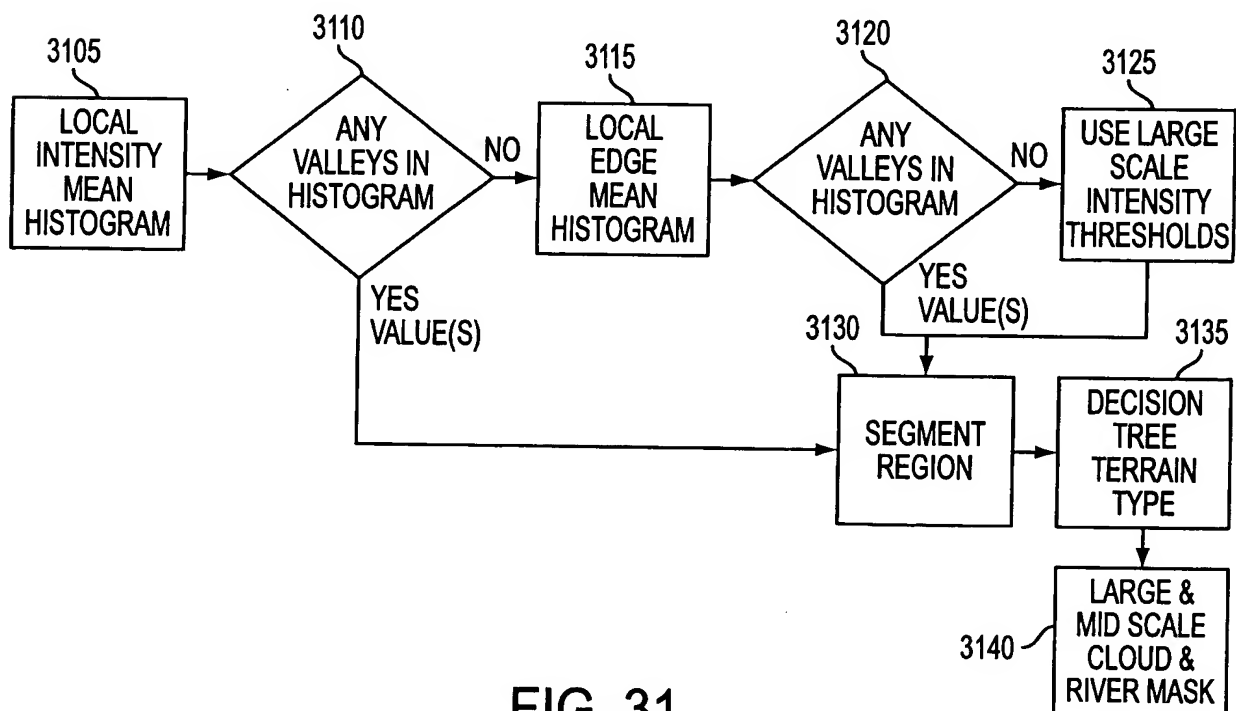


FIG. 31

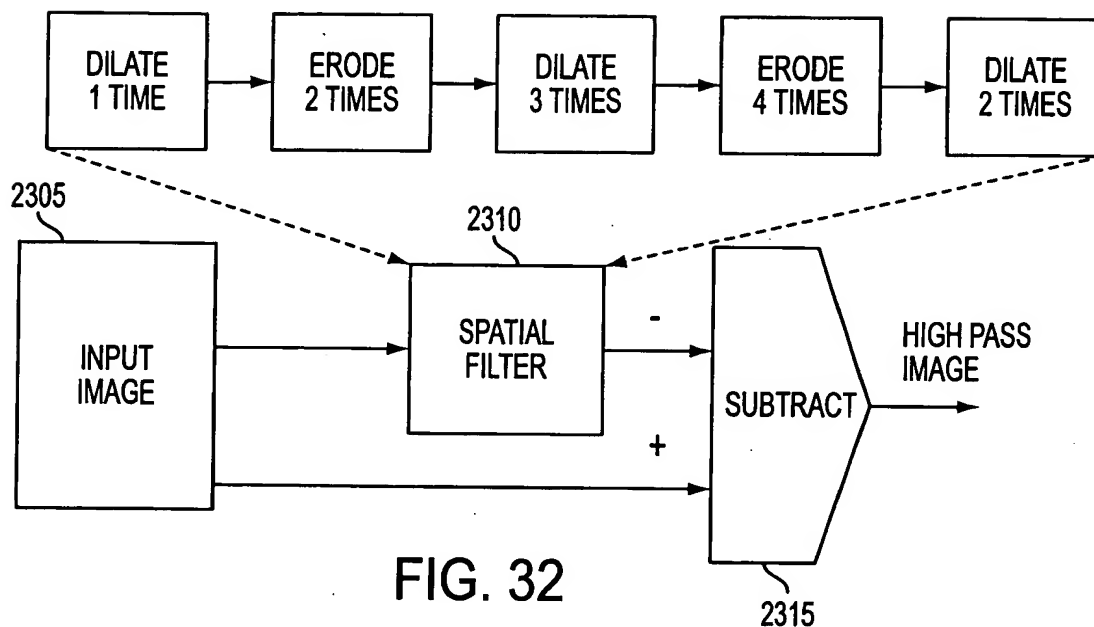


FIG. 32

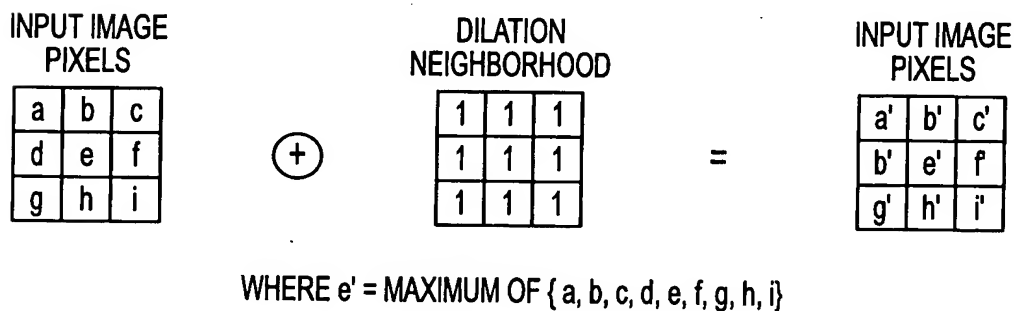


FIG. 33A

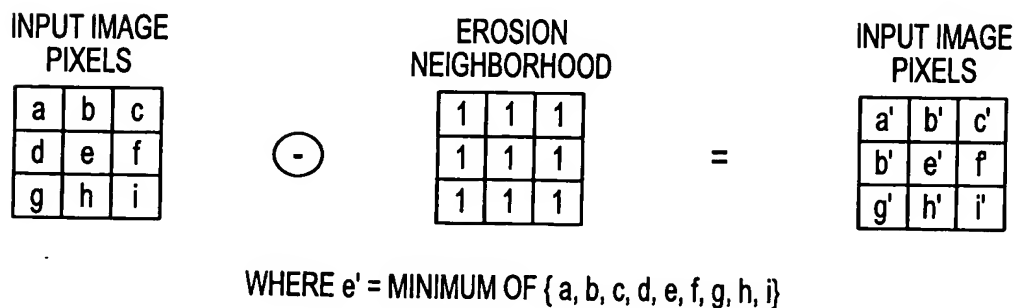


FIG. 33B

1 1 1	-1 0 1	0 1 1	-1 -1 0
0 0 0	-1 0 1	-1 0 1	-1 0 1
-1 -1 -1	-1 0 1	-1 -1 0	0 1 1
HORIZONTAL	VERTICAL	DIAGONAL 1	DIAGONAL 2

FIG. 34A

	HORIZONTAL		VERTICAL		DIAGONAL 1		DIAGONAL 2	
GRADIENT SIGN	+	-	+	-	+	-	+	-
DIRECTION	1	5	3	7	2	6	4	8

FIG. 34B

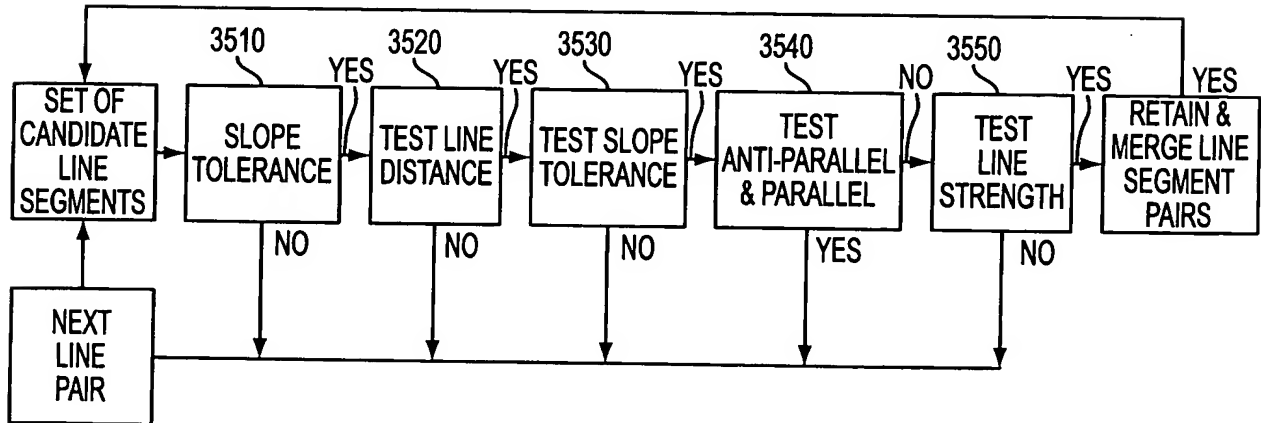


FIG. 35

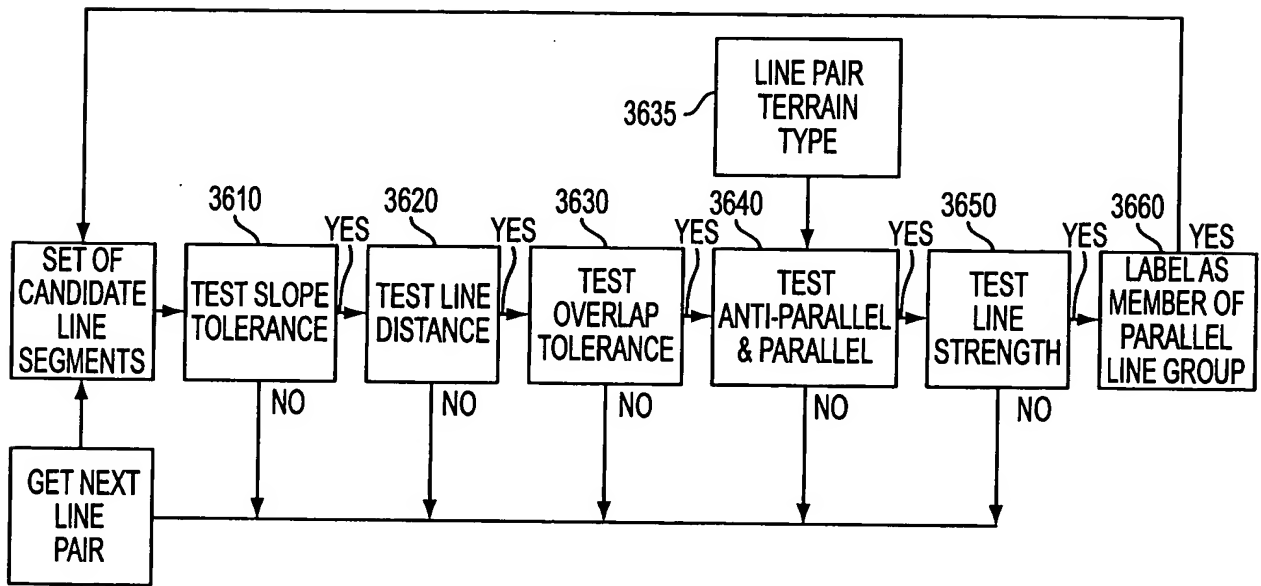


FIG. 36

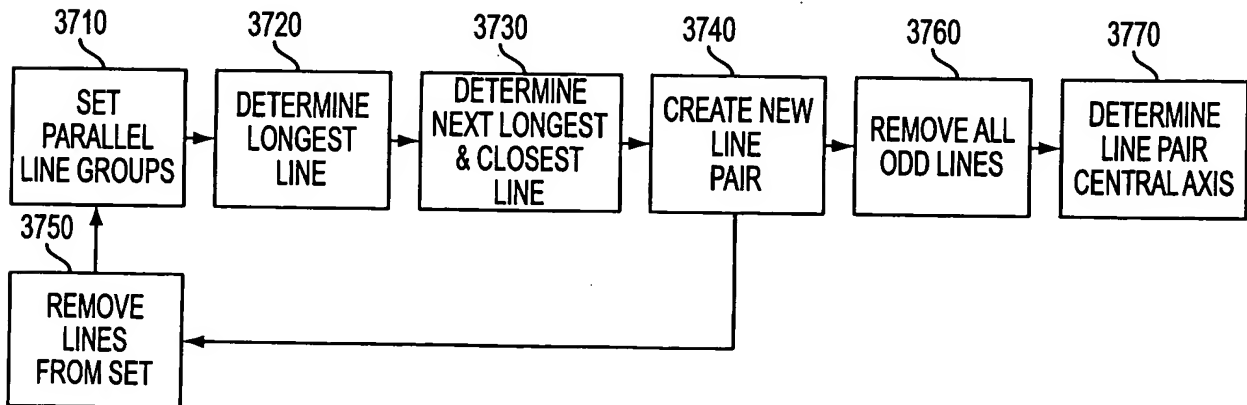


FIG. 37

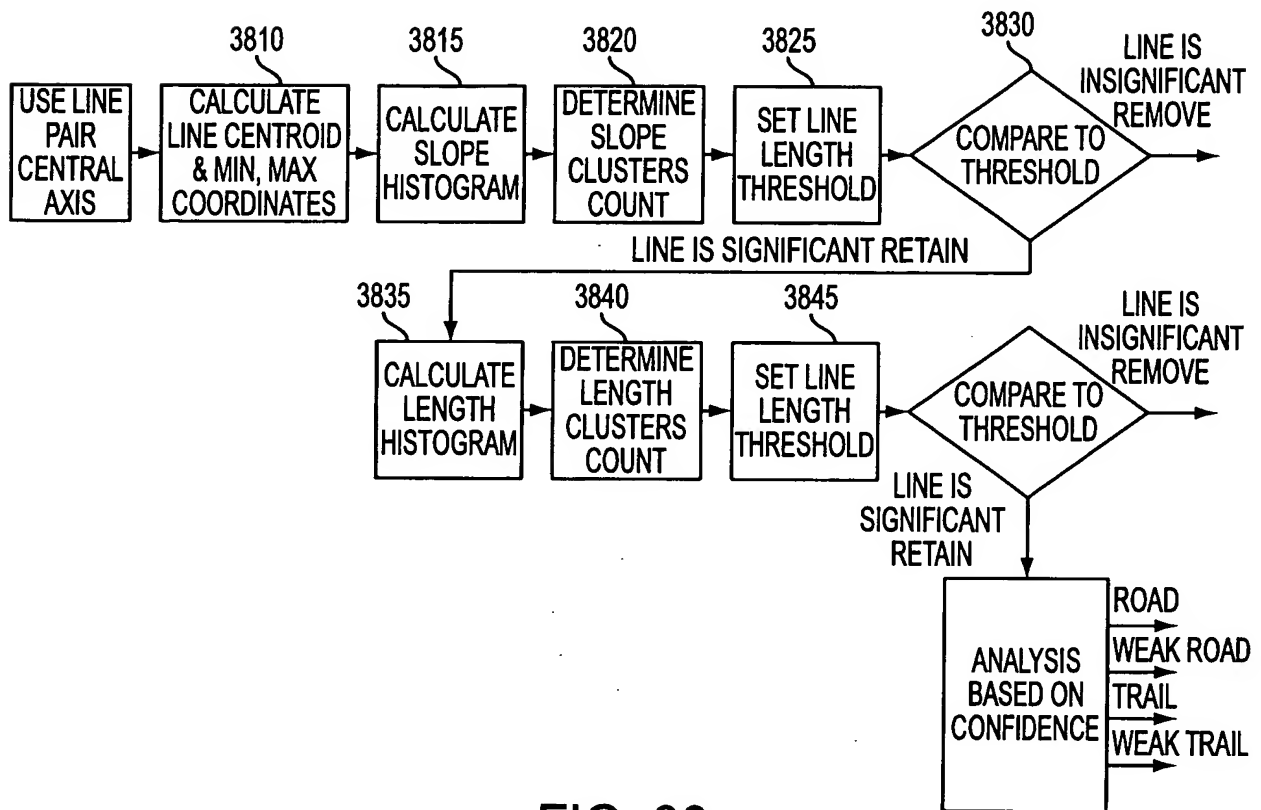


FIG. 38

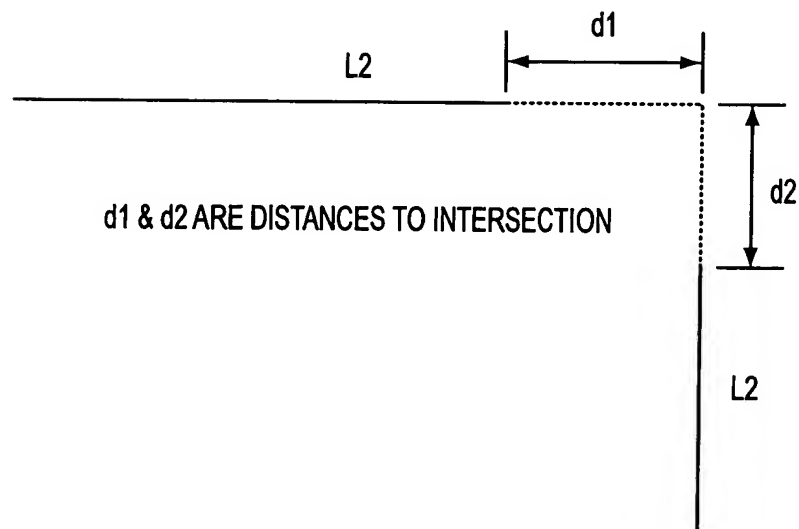


FIG. 39

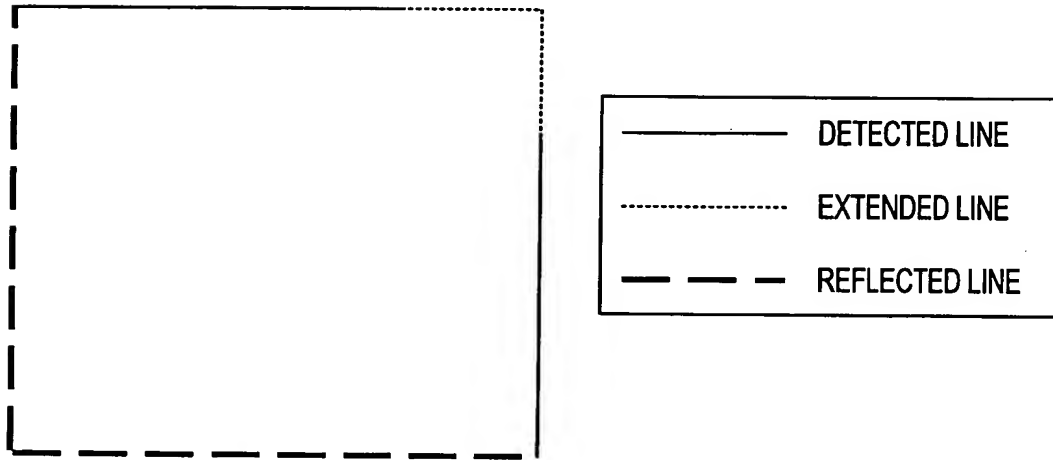


FIG. 40

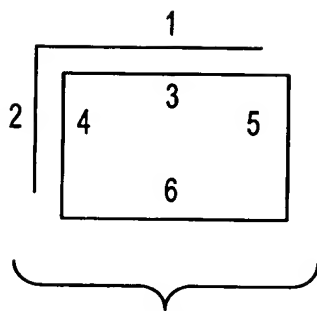


FIG. 41A

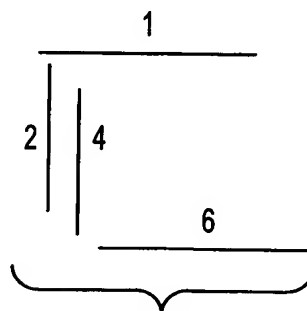


FIG. 41B

REFLECTED AND EXTENDED

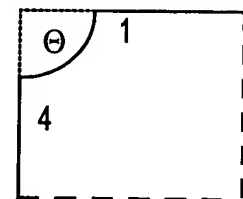


FIG. 41C

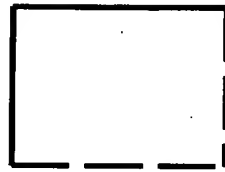


FIG. 42A

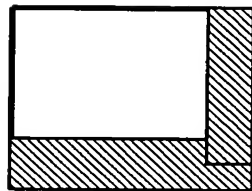
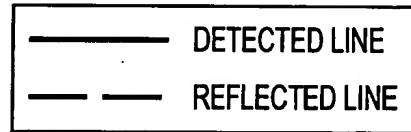


FIG. 42B

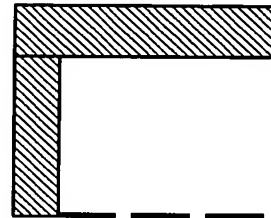


FIG. 42C

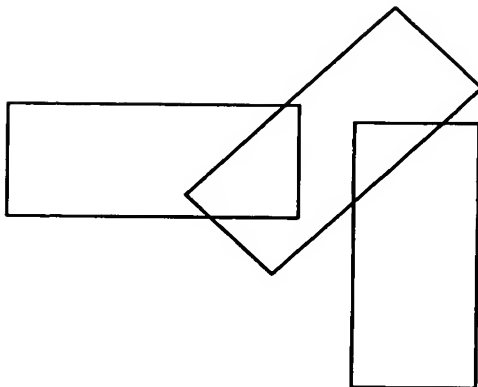


FIG. 43A

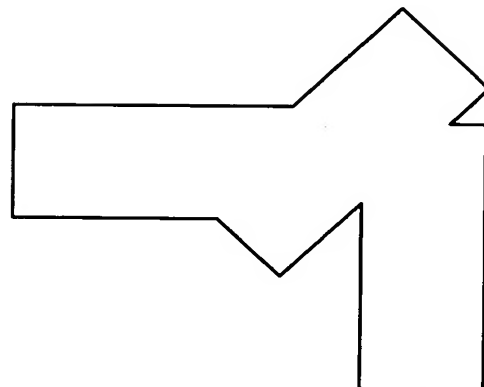


FIG. 43B

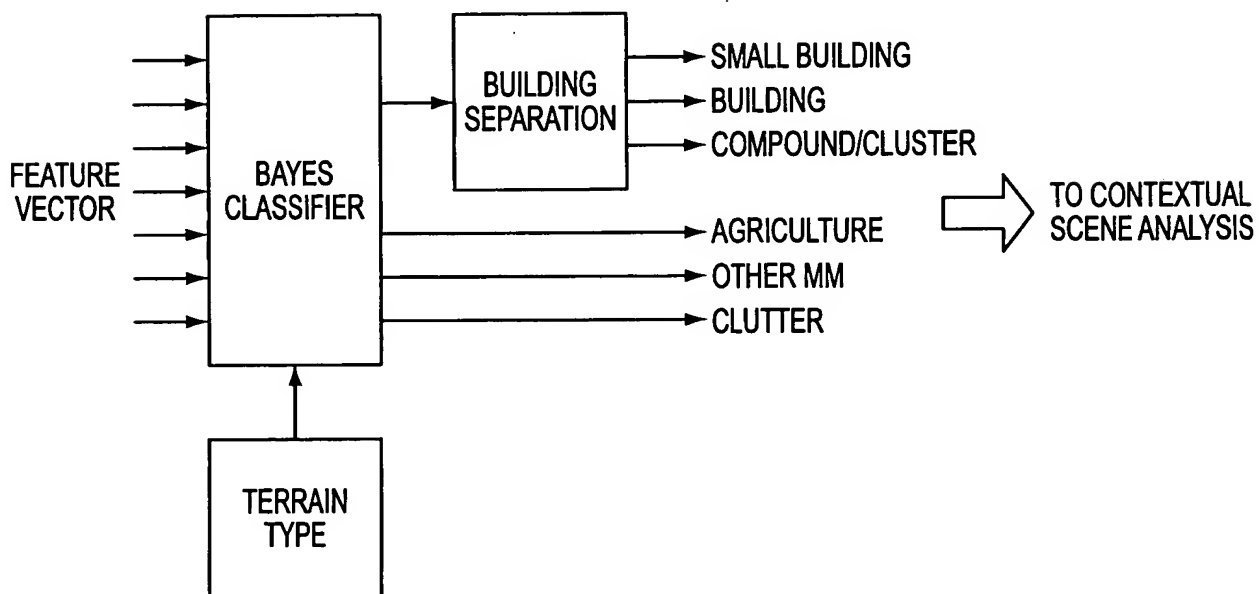


FIG. 44

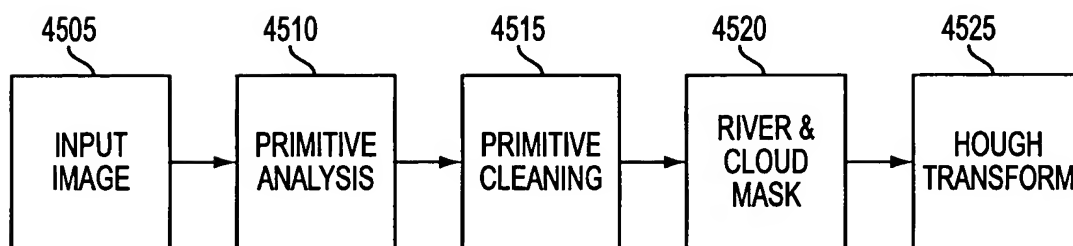


FIG. 45

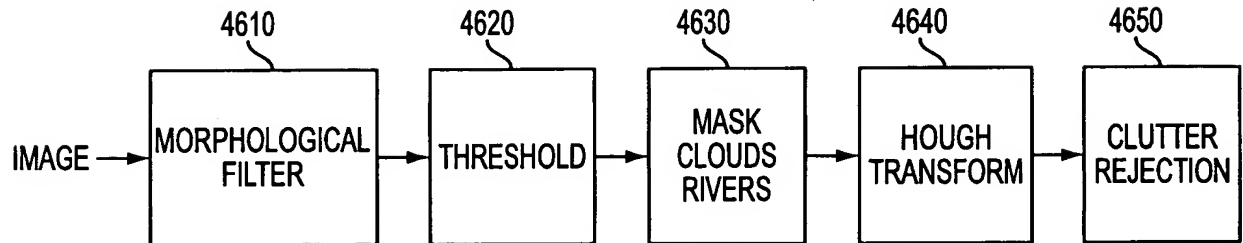


FIG. 46

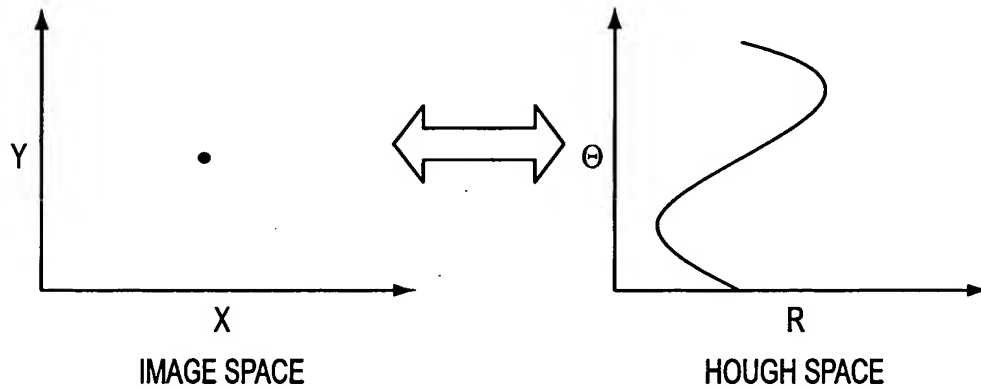


FIG. 47A

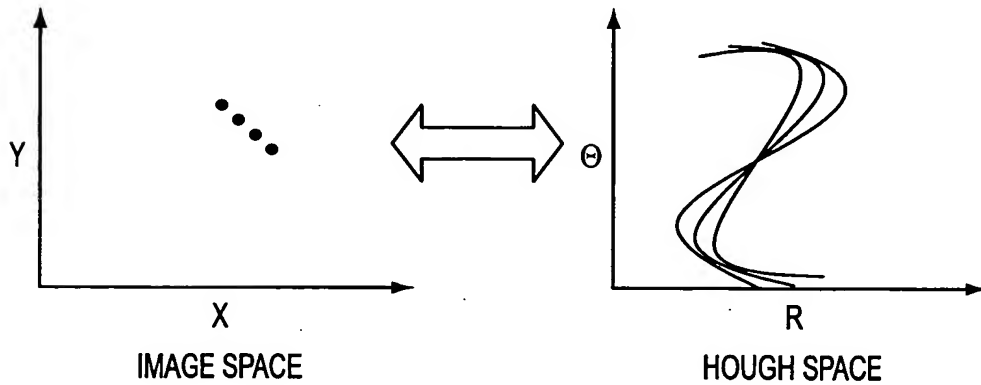


FIG. 47B

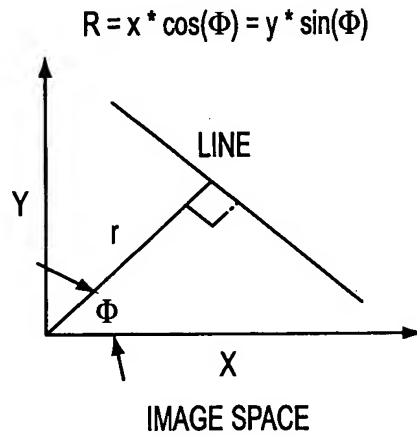


FIG. 48

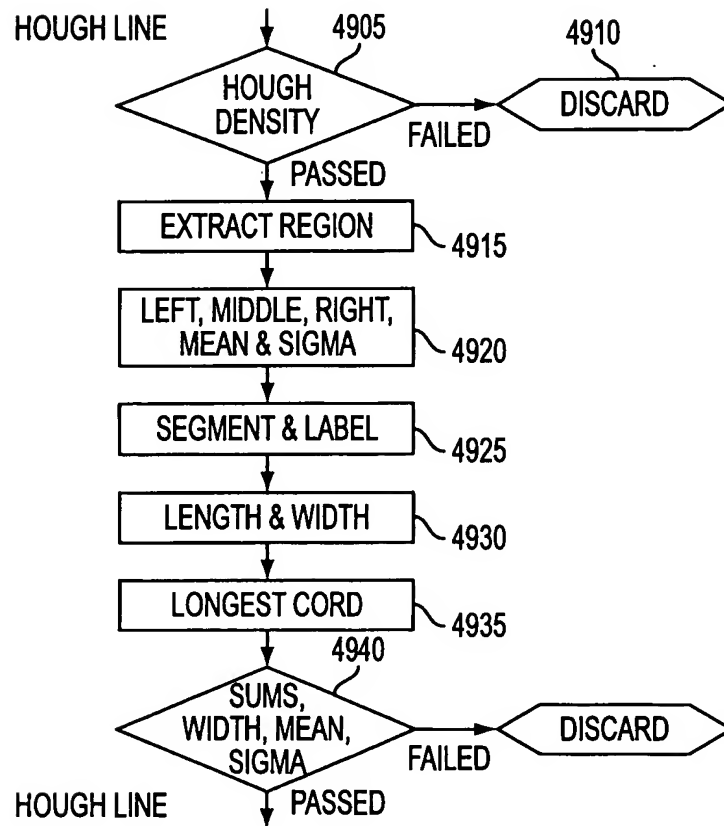


FIG. 49

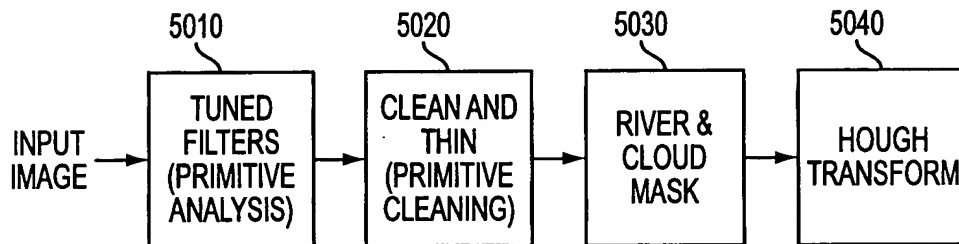


FIG. 50

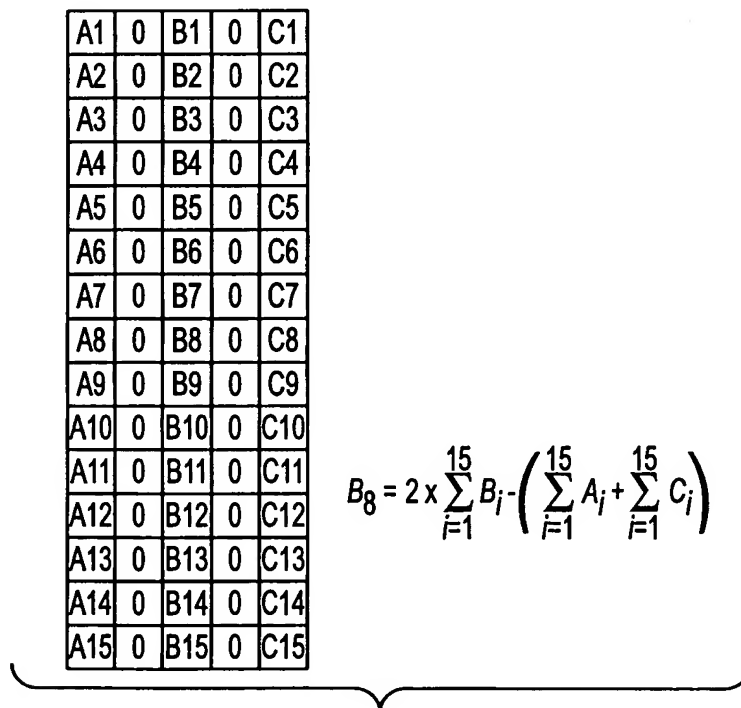


FIG. 51

A1	A2	A3	A4	A5
A16	B1	B2	B3	A6
A15	B4	B5	B6	A7
A14	B7	B8	B9	A8
A13	A12	A11	A10	A9

FIG. 52

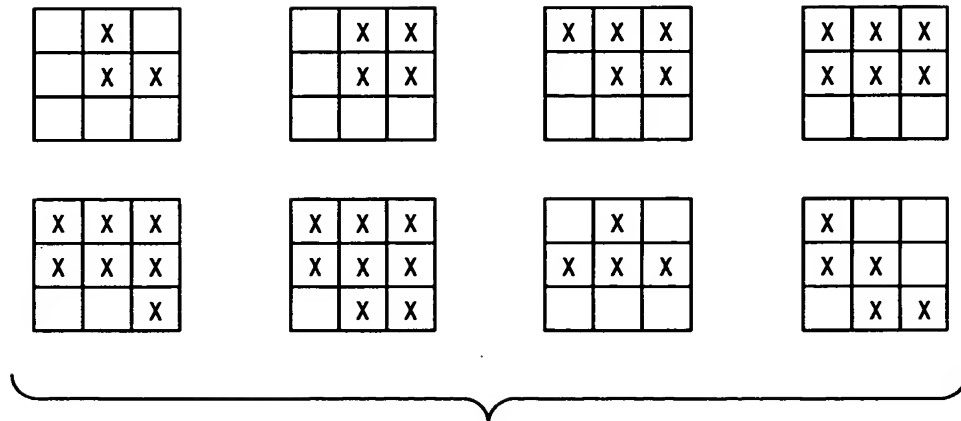


FIG. 53

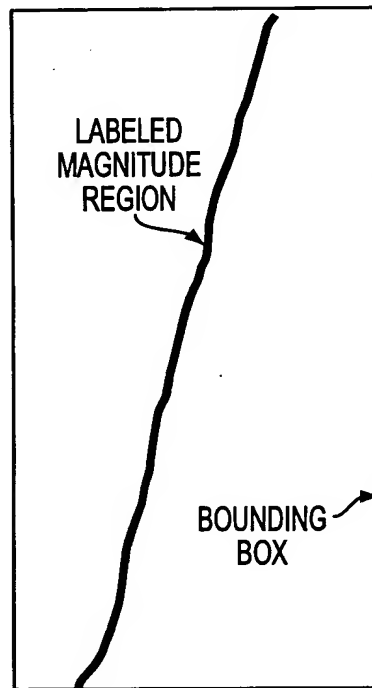


FIG. 54

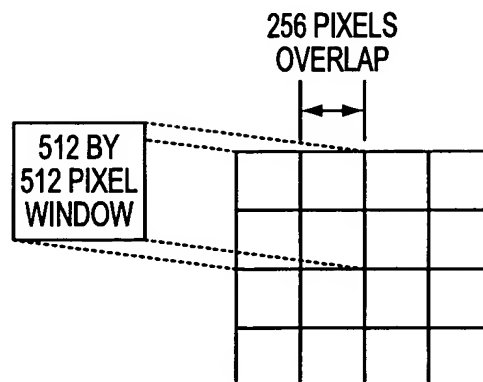


FIG. 55

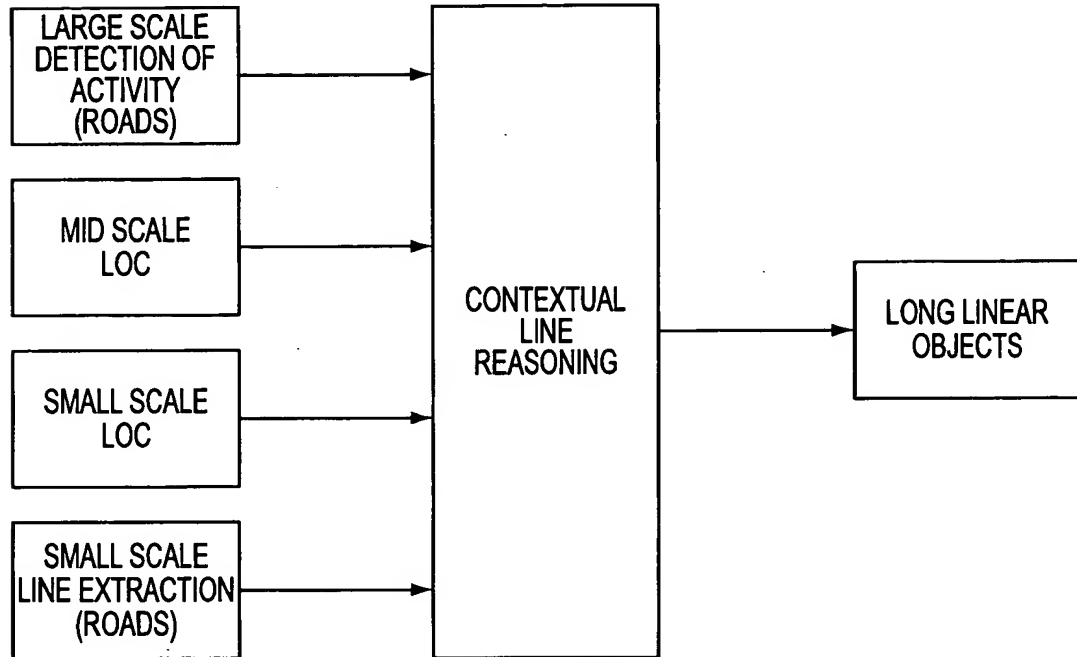


FIG. 56

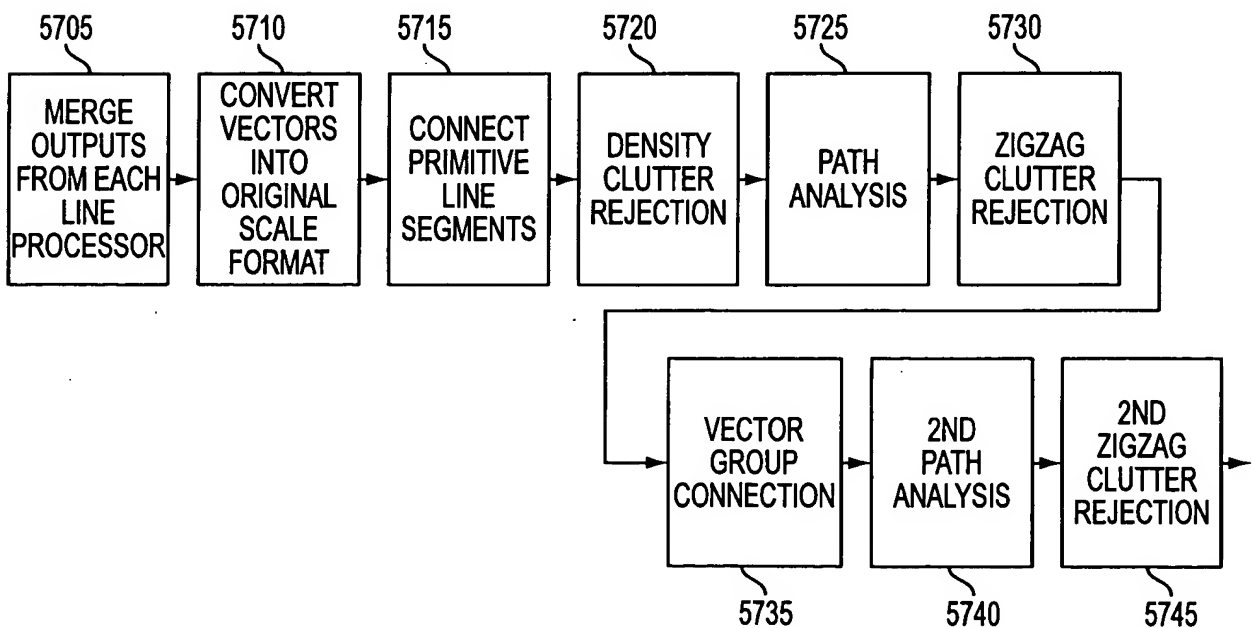


FIG. 57

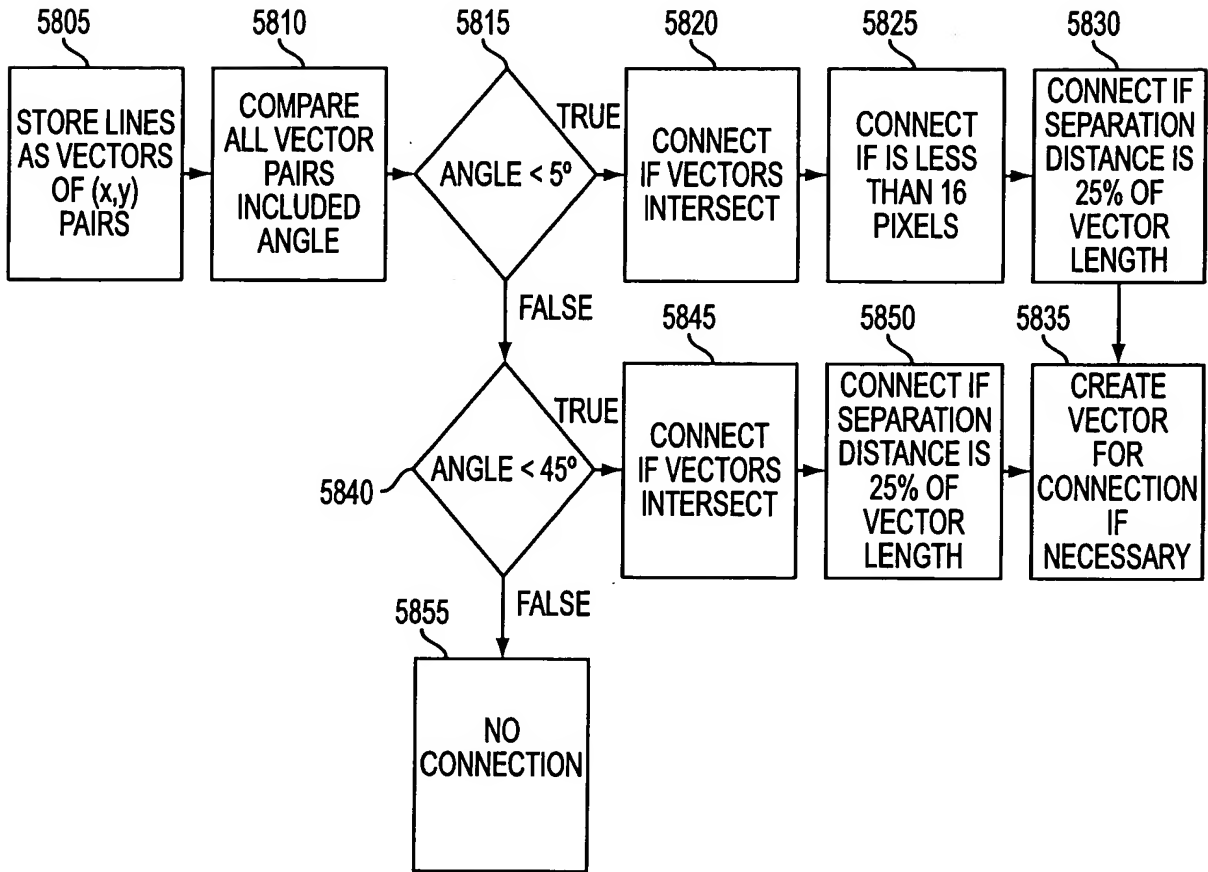


FIG. 58

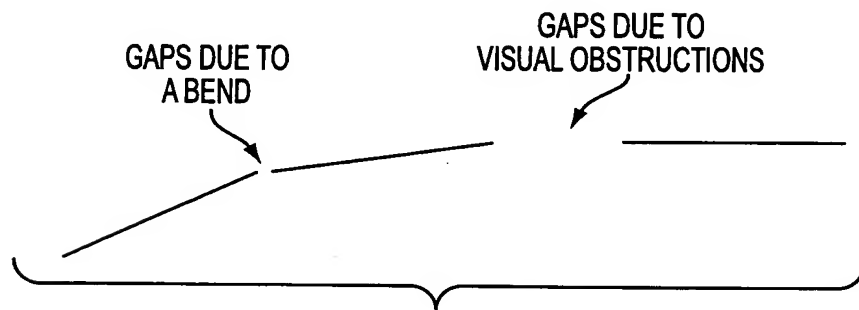


FIG. 59A

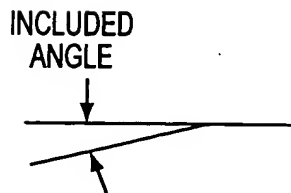


FIG. 59B

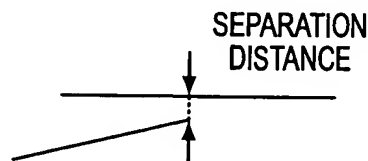


FIG. 59C

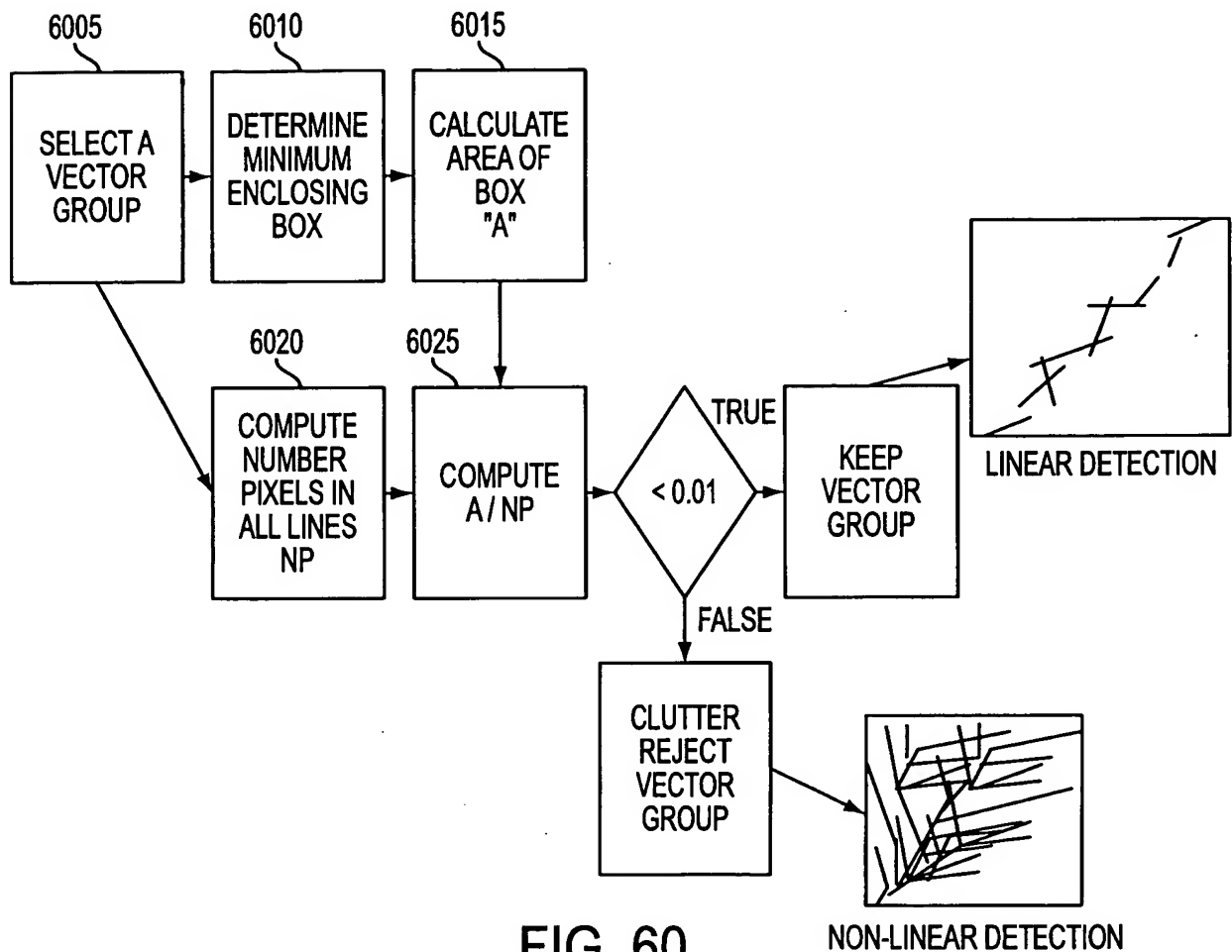


FIG. 60

$$M^1 = \|m_{ij}^1\| \text{ WHERE } m_{ij}^1 \text{ IS THE DIRECT DISTANCE}$$

BETWEEN NODE i AND j IN PIXELS

$$M^2 = \|m_{ij}^2\| \text{ WHERE } m_{ij}^2 \text{ IS THE DIRECT DISTANCE}$$

BETWEEN NODE i AND j IN PIXELS USING A MOST ONE INTERMEDIATE NODE

$$M^2 = M^1 \otimes M^1$$

$$M^4 = M^2 \otimes M^2$$

IN GENERAL THE FOLLOWING IS TRUE

$$M^{n+m} = M^n \otimes M^m$$

WHEN $M^t \equiv M^{t+\alpha}$ WHERE α IS A POSITIVE NUMBER

ALL PATHS ARE CONNECT

FIG. 61

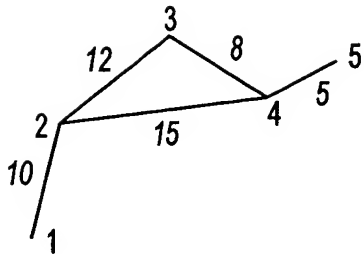


FIG. 62A

$$M^1 = \begin{matrix} & 0 & 10 & 0 & 0 & 0 \\ & x & 0 & 12 & 15 & 0 \\ x & x & x & 0 & 8 & 0 \\ & x & x & x & 0 & 5 \\ & x & x & x & x & 0 \end{matrix}$$

FIG. 62B

$$M^3 = \begin{matrix} & 0 & 10 & 22 & 25 & 30 \\ & x & 0 & 12 & 15 & 20 \\ x & x & x & 0 & 8 & 13 \\ & x & x & x & 0 & 5 \\ & x & x & x & x & 0 \end{matrix}$$

FIG. 62D

$$M^2 = \begin{matrix} & 0 & 10 & 22 & 25 & 0 \\ & x & 0 & 12 & 15 & 20 \\ x & x & x & 0 & 8 & 13 \\ & x & x & x & 0 & 5 \\ & x & x & x & x & 0 \end{matrix}$$

FIG. 62C

$$M^3 = M^4$$

FIG. 62E

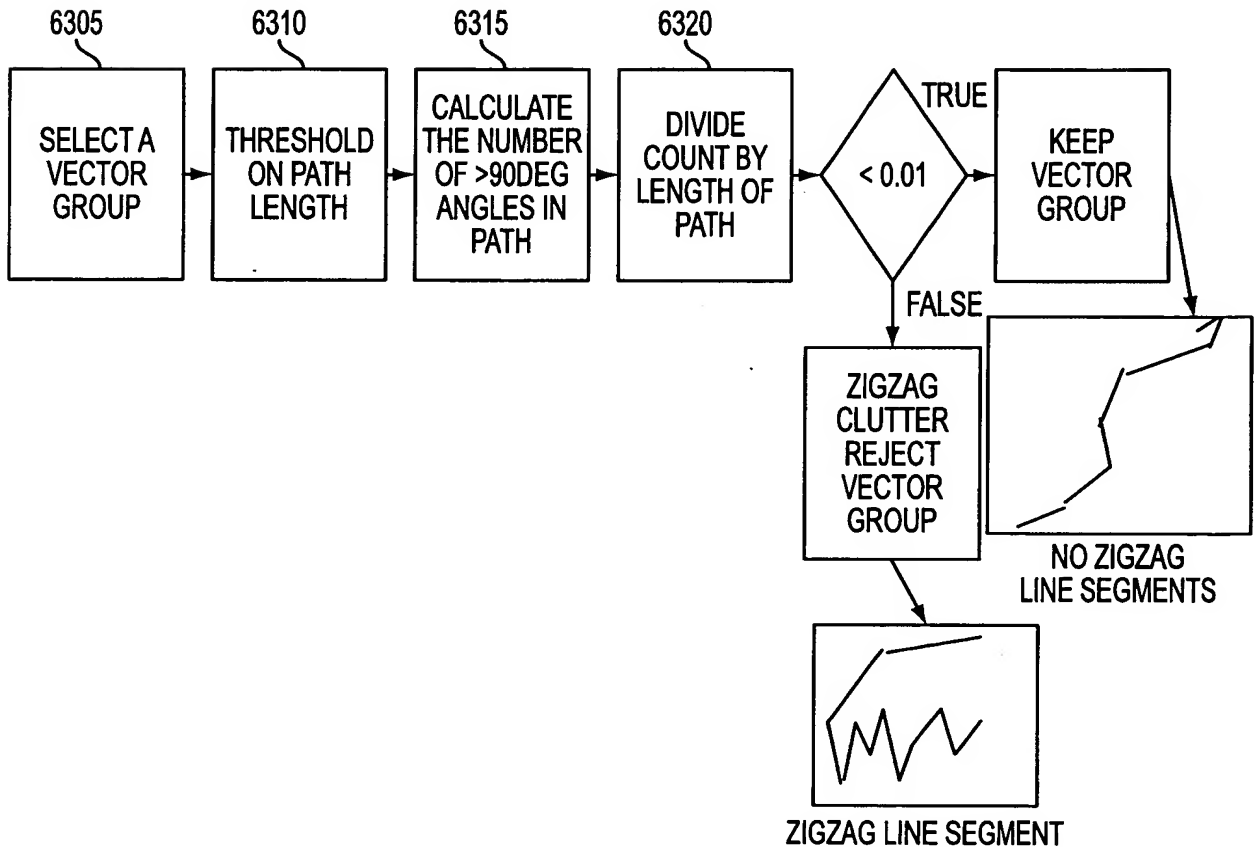


FIG. 63

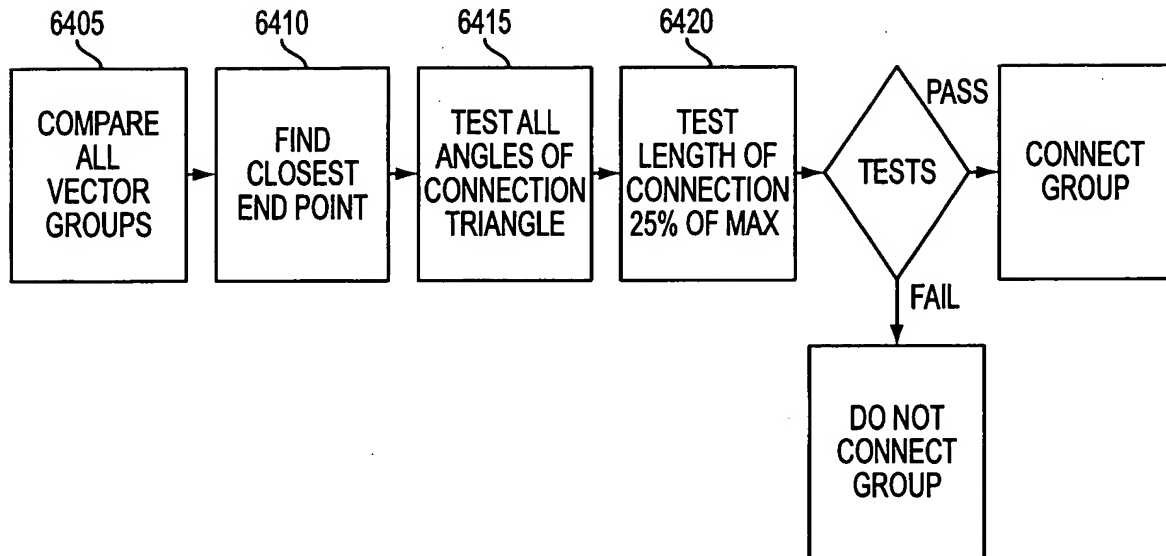


FIG. 64

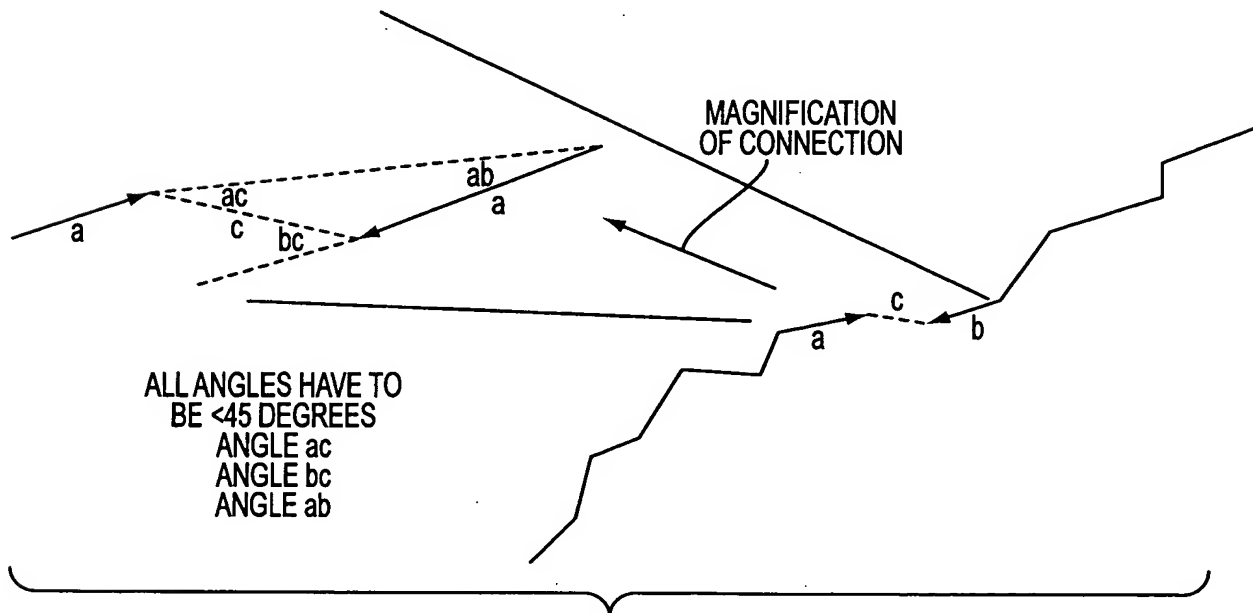


FIG. 65

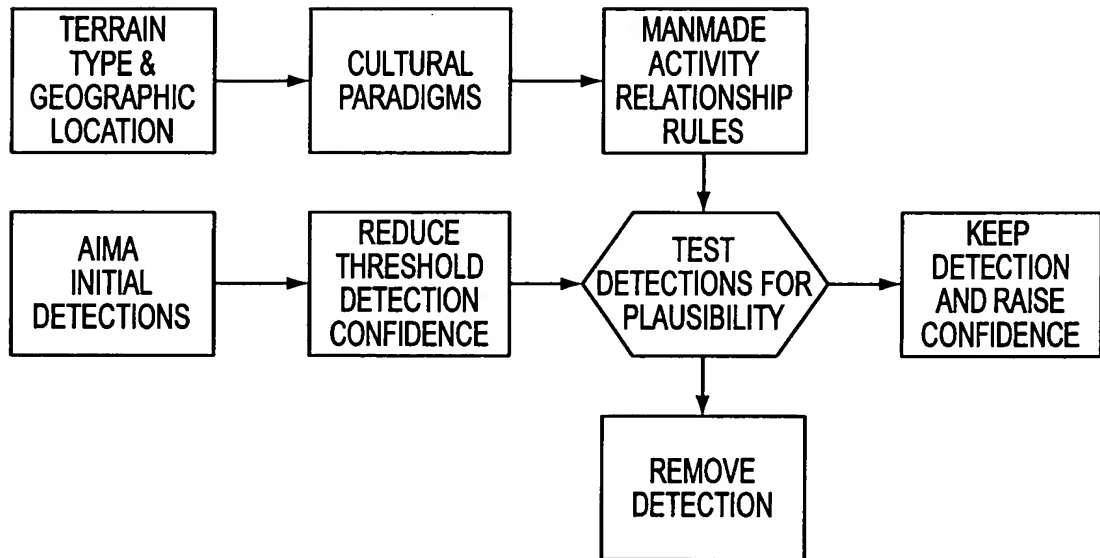


FIG. 66